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A 58.9
R 31
3-1

ARS 42-3-1
January 1963

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

ELECTRIC INSECT TRAPS FOR SURVEY PURPOSES[1]

by J. P. Hollingsworth, J. G. Hartsock, and J. M. Stanley[2]

Insect trapping devices equipped with electric lamps as attractants have proved to be valuable tools in entomological surveys for determining the presence, abundance, and time of occurrence of many species of insects of economic importance. Such traps also have been used successfully to collect particular species of insects in conjunction with research studies pertaining to various phases of entomology. Traps designed for these purposes commonly are known as survey-type electric insect traps.

This report describes the design, construction, and operational features of several general-purpose survey traps that have resulted from investigations conducted by personnel of the Farm Electrification Research Branch, Agricultural Engineering Research Division, Agricultural Research Service, U.S. Department of Agriculture, in cooperation with agricultural engineers and entomologists of Federal and State agencies. It also describes certain special-purpose survey traps, some of which were developed by personnel of other organizations. A partial list of insects of economic importance that have been collected by the various types of traps and a bibliography of recent publications on the subject are included.

TRAP ESSENTIALS

The survey-type electric insect trap consists essentially of (a) an attractant lamp and (b) a collection device. The collection device comprises an insect killing or collecting chamber and a lamp housing, including a lamp support, access opening or funnel to the killing or collecting chamber, baffles, mounting or suspension device, and other accessories.

1/ Cooperation in this research was provided by Entomology Research and Plant Pest Control Divisions, ARS, USDA, and several State entomologists including Dr. H. O. Deay of Purdue University who also provided the list of photopositive insects.

2/ Agricultural Engineers, Agricultural Engineering Research Division, ARS, USDA, College Station, Texas, Beltsville, Maryland, and Blacksburg, Virginia, respectively.

The Attractant Lamp

The attractant lamp is of primary importance in determining the effectiveness of the survey trap since it is the element most active in inducing insects to approach. Tests have shown that general-purpose survey traps (figs. 1 to 4, inclusive) are most effective when equipped with lamps that emit their principal radiation in the near-ultraviolet region of the electromagnetic spectrum (3,200 to 3,800 angstroms). Radiant energy in this region commonly is called black light. Black-light (BL) fluorescent lamps, especially in the 15-watt size (Type F15T8/BL), are widely used in general-purpose survey traps. Traps equipped with one 15-watt BL lamp have collected most economic species of nocturnal insects that are known to be photopositive. Other advantages of BL lamps, in addition to great attractiveness, are low cost, long life, low energy consumption, ability to stand weather exposure, and the availability of low-cost auxiliary operating equipment.

However, the great attractiveness of BL lamps may prove to be a disadvantage, particularly if one desires to collect only certain insect species. The problem of choosing selective attractants is complicated by the fact that attractiveness appears to be influenced not only by the wavelengths and relative magnitudes of the radiation components, but also by the size, shape, and brightness of the source.

Some progress has been made in developing special-purpose survey traps (figs. 5 to 8, inclusive). A trap (fig. 5) equipped with three 2-watt argon glow lamps has been used extensively for pink bollworm detection and survey because it attracts a smaller proportion of unwanted insects than does a 15-watt BL lamp. Incandescent lamps appear somewhat selective in attracting European corn borer moths. The mosquito trap (fig. 8), equipped with a 25-watt incandescent lamp, is another example of a special-purpose trap.

Collection Devices

The basic design for survey traps involves the use of a lamp mounted above a funnel. The insects are collected in a jar or can mounted at the bottom of the funnel. Except for the mosquito trap (fig. 8) and the cigarette beetle trap (fig. 6), in which an air stream forces insects into the collection funnel, the typical survey trap has no mechanical aid for forcing the insects into the collection device. This minimizes damage to the specimens. The traps collect only those insects that fly or fall into the funnel below the lamp.

The attractant lamp can be held or mounted in several ways. The most common is to mount the lamp at the juncture of vertical baffles. The baffles not only afford a convenient means of attaching and supporting the lamp sockets but also improve trapping efficiency. The exact manner in which the baffles function to improve trapping efficiency is not clearly established. However, various tests and observations suggest that they probably increase the effectiveness of the attractant by reflecting radiation from the lamp,

and provide obstructions to the flight of insects as they attempt to circle about the lamp.

Tests with different baffle materials and finishes have indicated no particular advantage for any one material or combination of materials. The choice of material is dictated primarily by durability, cost, and ease of fabrication. Lightweight galvanized sheet metal is adequate for most applications. The number of baffles required for optimum trapping efficiency apparently varies. Baffles have been proved to be a distinct disadvantage on traps for leafhopper surveys since these insects tend to rest on the baffles instead of entering the collection funnel. However, for most species of insects, two baffles (two vertical obstructions, or baffles, in the same plane, one on each side of the lamp) appear to be advantageous. For certain smaller moths, particularly the pink bollworm moth, traps with four baffles are more effective than traps with fewer baffles.

Trapping efficiency is influenced somewhat by the dimensions of the funnel. In general, the size of the collection in traps equipped with vertically mounted lamps increases as the diameter of the funnel top increases. Funnel-top diameters at least three-fourths the length of the lamp commonly are used. Funnel slope is maintained at a sufficiently steep angle to prevent insects from clinging to the inner surfaces. Proper funnel slopes are maintained by making the height of the funnel equal to or greater than the diameter of the top of the funnel. Funnel outlet openings about 2 inches in diameter give a reasonable compromise between troubles from clogging by large moths and the escape of smaller species from the collection device at the bottom of the funnel.

Various arrangements are used for collecting and retaining the insects after they pass through the funnel. The simplest arrangement involves the use of a wide-mouth mason jar fitted to the funnel base. The unidirectional trap shown in figure 1 is this design.

The omnidirectional trap (figs. 2, 3, and 4) exposes the lamp and upper funnel opening to rain, and therefore has a collection device designed to drain moisture from the trap and prevent its contact with the collected specimens. This is accomplished in the trap shown in figure 2 by a tube extension at the funnel bottom, which discharges water through a screened-top drain cone located within the collection can. The extension tube also helps prevent the insects from escaping from the collection can during the short time required for inactivation by fumes of the killing agent. The traps shown in figures 3 and 4 do not have an extension tube since the funnel bottom is located near the top of the drain cone.

Both types of traps can be equipped with screened bags or boxes if it is desired to keep the insects alive and in good condition. They can be attached to the bottom of the trap funnel in place of the jar or can.

Some insect killing agents, particularly the cyanide materials, create an extremely corrosive atmosphere within the collection can. The useful

life of the collection device can be extended considerably by coating the inner surfaces with corrosion inhibitors such as acid-resistant paints or various forms of resinous materials.

Some separation of insects according to size can be attained by the use of sized screened trays within the collection can. No entirely satisfactory design for a collection device of this type has been developed, but the principle has shown enough promise to merit further investigations. Successful separation by size within the collection can would prevent much of the damage to small and delicate species that frequently occurs because of the inherent ability of certain beetles to withstand strong concentrations of killing agents for rather long periods.

Another technique for separating insects by size at time of collection is that of using a screen enclosure over the lamp and baffle assembly. The pink bollworm moth, for example, can pass readily through $\frac{1}{4}$-inch mesh screen. Screen of this mesh prevents the larger species of insects such as tomato hornworm moths and May beetles from entering the trap. However, tests have shown that screens used in this manner tend to reduce the total number of insects collected, including the smaller species. This factor must be considered if the trap is being used for insect detection.

POWER SUPPLY

The commonly used survey-type electric insect trap is designed to operate from standard 115-volt, 60-cycle alternating current. As with all portable electric appliances, safeguards must be provided against electric shock. Wiring should be done in compliance with the National Electrical Code and local requirements. All metal parts of the trap should be connected to a good electrical ground such as an underground metal water system or a pipe or rod driven into the ground. These ground connections should be interconnected to the grounded (neutral) conductor of the electrical system by polarized connectors.

The need often arises for operating traps at locations remote from central-station electric service. If the distance between the power source and the trap is not excessive, the best solution to the power extension problem is a small moisture-resistant three-conductor cable. Since the electrical load imposed by the trap is small, power extension by this method is limited primarily by the cost of cabling and by the problem of physically handling and distributing the cable. In some locations extension cabling is impractical and portable power supplies are necessary. Because of equipment and service costs, gasoline-driven generators are usually not practical unless several traps are to be operated within a rather small area. Automotive-type storage batteries used in conjunction with static inverters have proved to be the best portable power supply for individual traps. Static inverters with self-contained light-actuated "on-off" controls are now available commercially. Units of this type, specially designed for trap operation, are capable of providing from two to three nights of trap operation from a fully charged 12-volt 72-ampere-hour automotive battery.

Under most conditions where commercial power is used the lamps are operated continuously, since the amount of energy used is very small. This eliminates the need for an automatic switch and assures that the trap will be on when the insects are flying.

Limited studies in Texas on the effect of frequency of lamp supply voltage on lamp attractiveness have indicated no advantage for operational frequencies different from 60 c.p.s. Except for 0 c.p.s. (direct current), attractiveness has been reduced for frequencies below 32 c.p.s.

TRAP USE AND OPERATION

The traps may be mounted on posts, bipods, tripods, or suspended from overhead. The proximity and direction of the trap location in relation to particular crops and other vegetation and to buildings and other obstructions greatly influences the numbers and kinds of insects collected. Traps are generally located in an open area having some low ground cover such as pasture or low-growing forage crop. If a specific insect species is desired, locate near known host plants. The height at which traps are mounted also influences the numbers of insects collected. Certain species will be collected in greater numbers at specific heights. As a general rule, however, it is desirable to keep the trap just above the host crop.

The trap design also influences the numbers and kinds of insects collected. More insects are generally attracted to unidirectional traps if such traps face downwind so that the insects fly into the wind as they approach the trap. Traps should be located in areas of comparative darkness, at least 500 feet from the nearest directly competing light source.

If the information obtained from survey traps is to be successfully used in comparing data obtained in two localities in the same season, or in comparing data obtained year after year in the same locality, trap location, height, and relationship to ground cover and to host crop must be maintained reasonably constant. Also, it is advisable to replace the lamps at the beginning of each season. Depreciation of the ultraviolet output of BL fluorescent lamps is very slow and these lamps can be used for a full season under ordinary conditions.

Environment also will exert considerable influence on trap collections. Large variations in catches occur as a result of differences in nightly wind, temperature, humidity, and amount and duration of moonlight. Although these factors cannot be controlled, weather records will prove helpful in interpreting results of trap operations.

GENERAL SURVEY TRAPS

The arrangement used for mounting the attractant lamp determines the area of surrounding space from which the lamp is visible. This limitation fundamentally affects the capability of any light trap to attract insects, so traps must be further classified on the basis of their lamp mounting. This is of particular importance to properly evaluate catches from various types of traps in general survey operations.

Traps that expose the lamp to view from one side only are termed "unidirectional," while those that are visible from all sides are termed "omnidirectional." Obviously, all methods of lamp mounting and all types of rain covers create some shadows, so these classifications are general and the characteristics of individual traps should be considered in selecting units for particular applications.

Four traps that have proved successful for general surveys are shown in figures 1 through 4, with construction details given in the drawings on the back of each illustration (see pages 7 to 14, inclusive).

SPECIALIZED SURVEY TRAPS

The traps shown in figures 5, 6, 7, and 8 have special design features that adapt them for use in surveys involving specific insect pests.

DISPOSITION OF INSECTS

For the traps to be effective as a survey tool, it is necessary for the insects to be maintained in a condition that will facilitate identification. The collected specimens must be killed as rapidly as possible to reduce the loss of scales from moths and the obliteration or loss of other features required for positive determinations.

Most of the materials used as killing agents are highly toxic and must be used with extreme care.

Many operators use cyanide in one of the various available forms (usually calcium cyanide) for this purpose. It is desirable to place a small amount of the material in a porous container, such as a paper bag, and to renew it each day that the trap is used.

Other operators have used ethyl acetate. When this is used, the insect collection container is frequently lined with a coating of plaster of paris which absorbs the liquid and makes the fumes available over the entire wall area of the container.

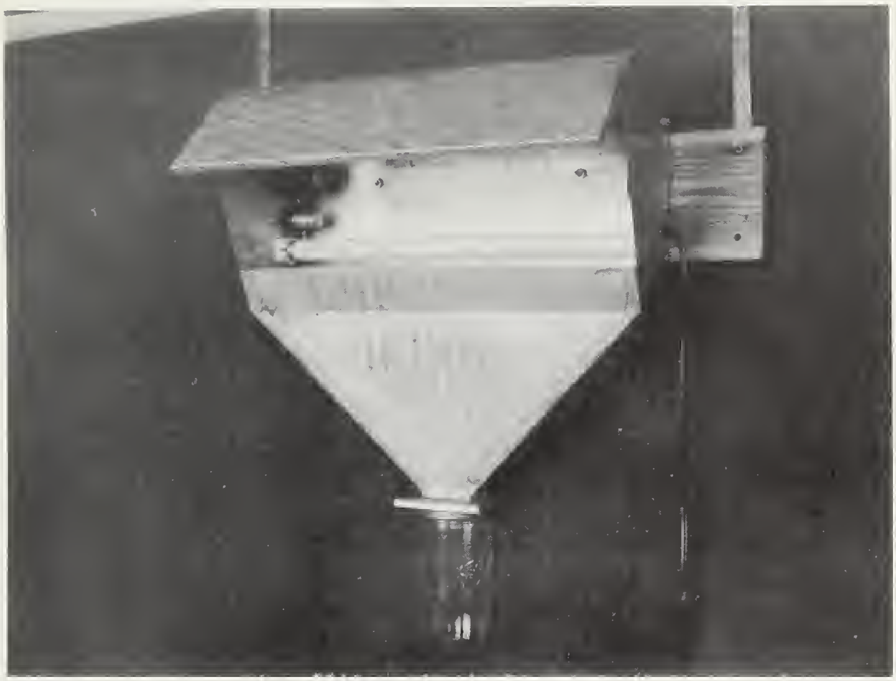
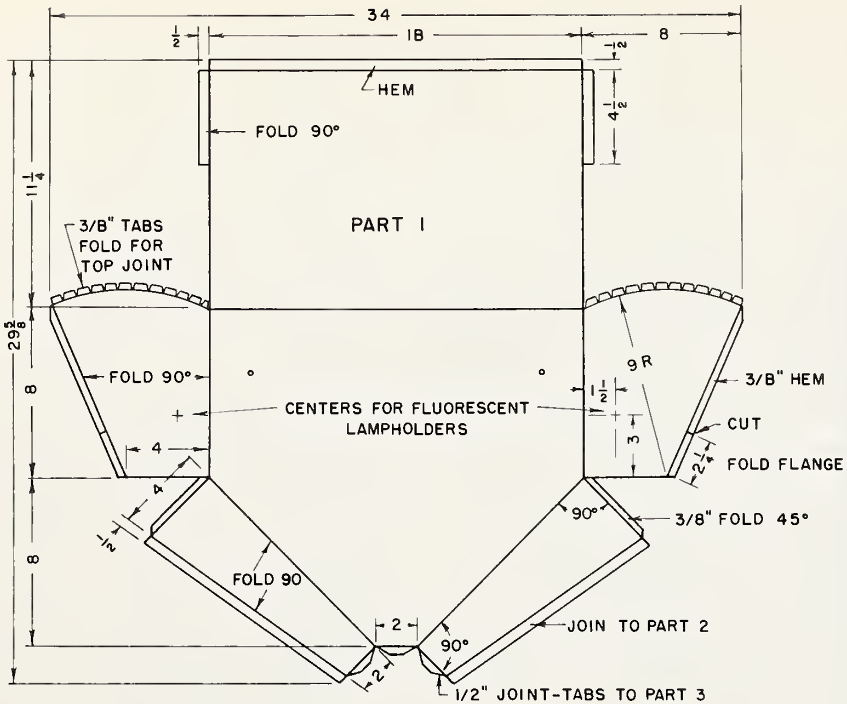
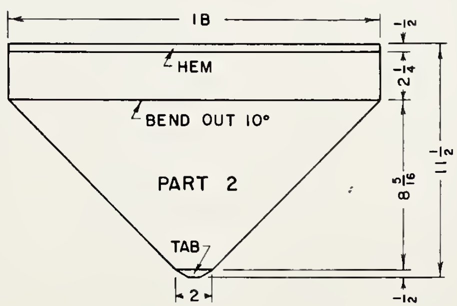


Figure 1.--15-watt unidirectional survey trap.

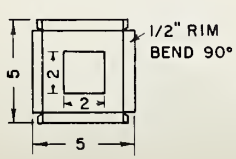
This trap is equipped with a horizontally mounted 15-watt BL fluorescent lamp. The size of the catch from this unit is approximately 1/3 to 1/2 as large as that usually obtained from omnidirectional traps of equal wattage because of the directional radiation pattern, but the species representation is good. The cover keeps most rainwater out, and the specimens are preserved in good condition. Ordinarily the trap should be mounted with the closed side toward the prevailing summer wind unless the ground cover dictates otherwise. This orientation provides maximum weather protection and takes advantage of the fact that insects normally fly into the wind. (Turn page for construction plan.)

(ARS 42-3-1, pp. 7-14, inclusive, January 1963)

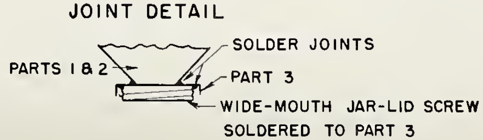




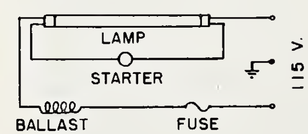
PART 3



JOINT DETAIL

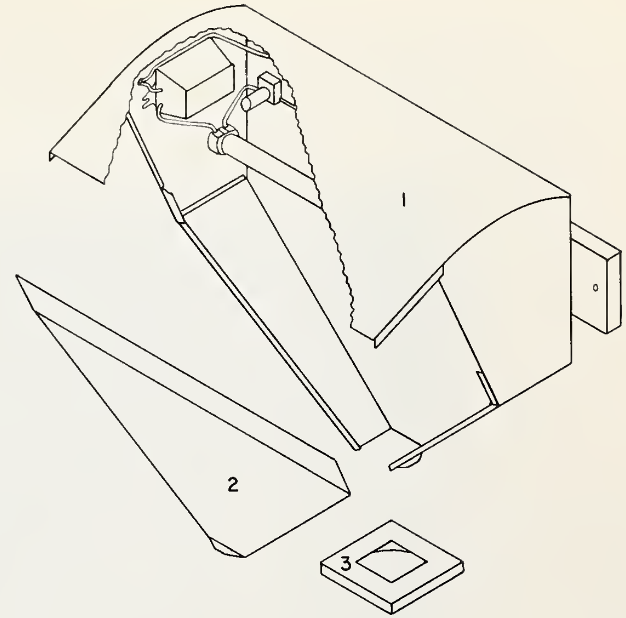


CIRCUIT



CIRCUIT
COMPONENTS

LAMPHOLDERS (2) - GE 503 X 59
LAMP - F15TB/BL
STARTERHOLDER - GE 95X299
STARTER - FS-2
BALLAST - GE 89G381
FUSE SOCKET - GE 5645-1
FUSE - 1-AMP. PLUG-TYPE
EQUIVALENTS OF ABOVE G.E. PARTS
MAY BE UTILIZED



NOTES:

1. MATERIAL: 26 GAUGE GALVANIZED STEEL
2. JOINTS SOLDERED WATERTIGHT
3. LOCATE FUSE, BALLAST & STARTER HIGH ON SIDES OF TRAP UNDER CANOPY
4. FREEZER, ICE CREAM OR OTHER SIMILAR CARTONS MAY BE USED AS CATCH CONTAINER BY OMITTING JAR LID & PROVIDING A SPRING SUSPENSION FROM PART 3
5. COMMERCIAL STRIP FIXTURES NOT EXCEEDING 18" LENGTH MAY BE SUBSTITUTED IN LAMP CIRCUIT

ELECTRIC INSECT TRAP UNIDIRECTIONAL TYPE 2-62
U.S. DEPARTMENT OF AGRICULTURE, ARS FARM ELECTRIFICATION BRANCH, AE, & PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION, LAFAYETTE, IND.

Figure 2.--15-watt omnidirectional survey trap.

The 15-watt BL fluorescent lamp in this trap is vertically mounted. The doughnut-shaped radiation pattern provided by this method of lamp mounting can influence insects approaching from any direction.

The trap has a metal can for collecting the insects and holding the killing agent. A screen-covered funnel within this can drains rainwater through an opening in the bottom. A small cone within the collection funnel above the opening into the can prevents direct entry of raindrops and reduces the number of escaping insects. Provision is also made to substitute a glass jar for the metal collection can, if desired. The trap is usually mounted on a tripod of pipe but other methods are equally satisfactory. (Turn page for construction plan.)

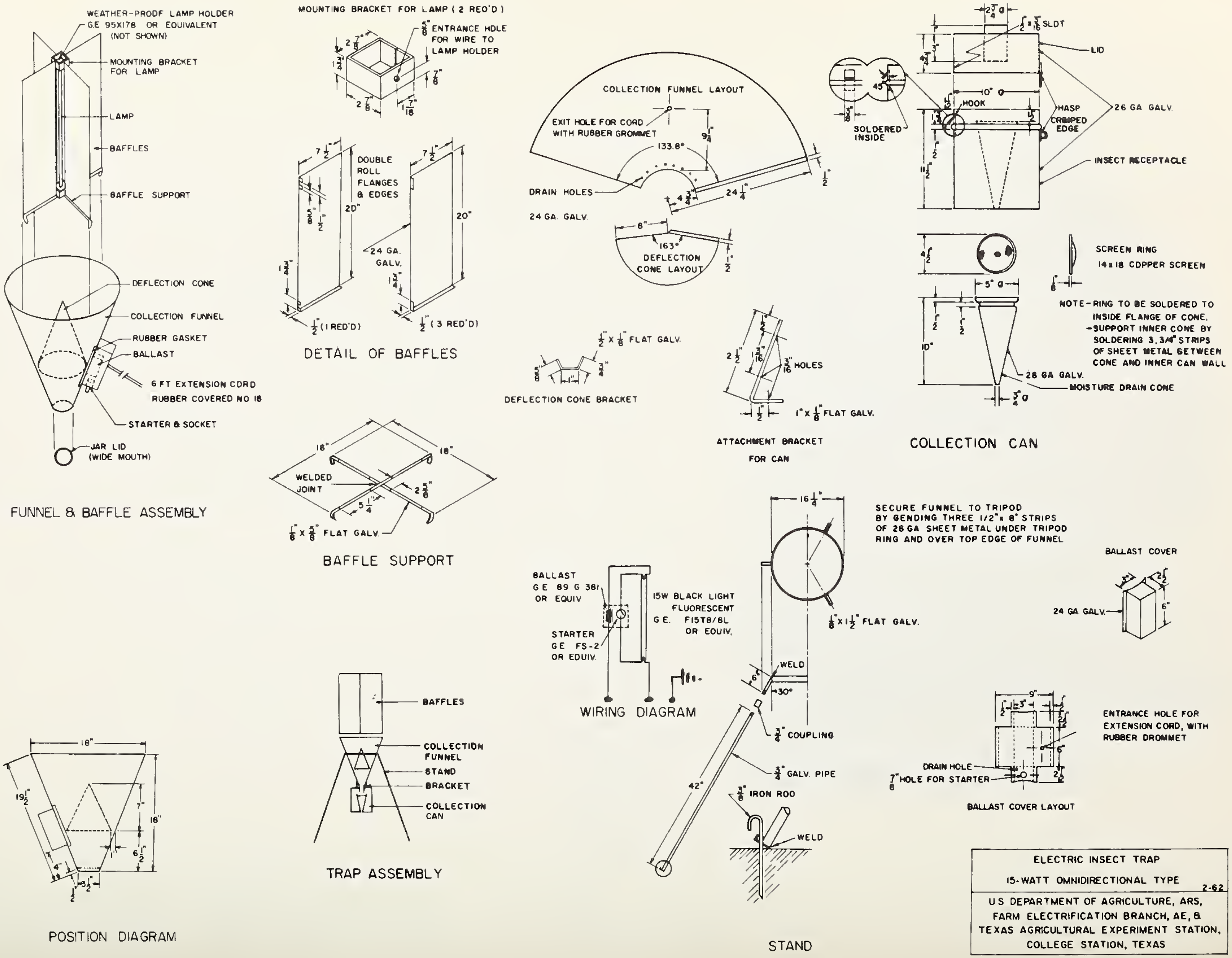
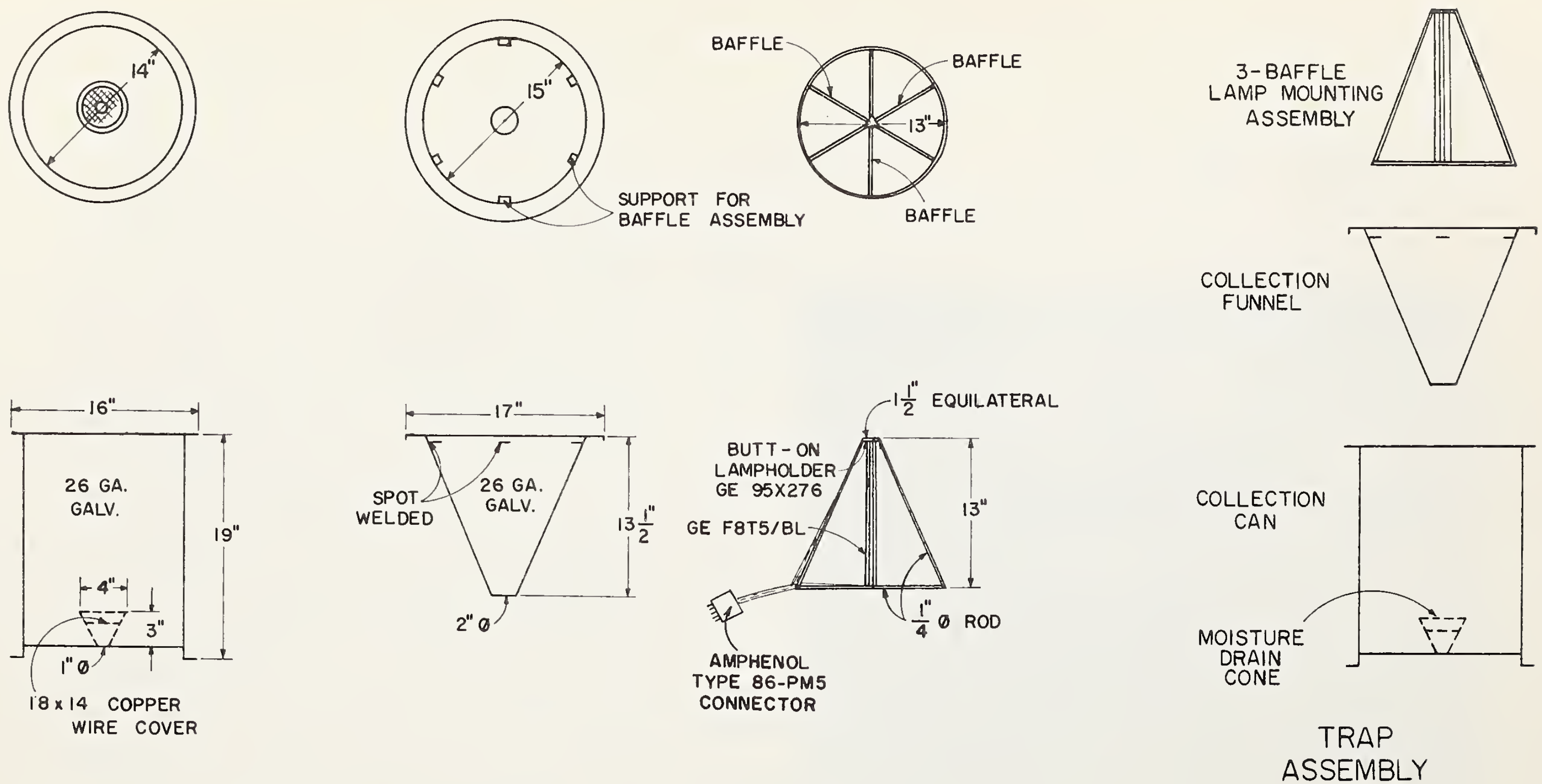
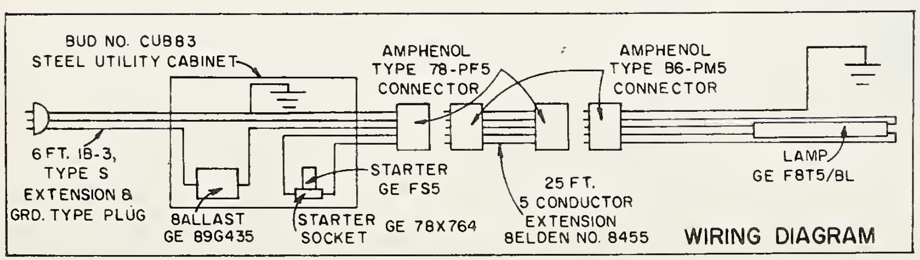

WEATHER-PROOF LAMP HOLDER GE 95X178 OR EQUIVALENT (NOT SHOWN)
MOUNTING BRACKET FOR LAMP
LAMP
BAFFLES
BAFFLE SUPPORT
DEFLECTION CONE
COLLECTION FUNNEL
RUBBER GASKET
BALLAST
6 FT EXTENSION CORD RUBBER COVERED NO 18
STARTER & SOCKET
JAR LID (WIDE MOUTH)
FUNNEL & BAFFLE ASSEMBLY
MOUNTING BRACKET FOR LAMP (2 REQ'D)
5/8" ENTRANCE HOLE FOR WIRE TO LAMP HOLDER
DOUBLE ROLL FLANGES & EDGES
24 GA. GALV.
1/2" (1 REQ'D)
1/2" (3 REQ'D)
DETAIL OF BAFFLES
WELDED JOINT
1/8" x 5/8" FLAT GALV.
BAFFLE SUPPORT
COLLECTION FUNNEL LAYOUT
EXIT HOLE FOR CORD WITH RUBBER GROMMET
133.8°
DRAIN HOLES
24 GA. GALV.
163°
DEFLECTION CONE LAYOUT
1/2" x 1/8" FLAT GALV.
DEFLECTION CONE BRACKET
3/16" HOLES
1" x 1/8" FLAT GALV.
ATTACHMENT BRACKET FOR CAN
1/2" x 3/16" SLOT
LID
HOOK
HASP
CRIMPED EDGE
26 GA GALV.
SOLDERED INSIDE
INSECT RECEPTACLE
SCREEN RING
14 x 18 COPPER SCREEN
NOTE - RING TO BE SOLDERED TO INSIDE FLANGE OF CONE.
- SUPPORT INNER CONE BY SOLDERING 3, 3/4" STRIPS OF SHEET METAL BETWEEN CONE AND INNER CAN WALL
28 GA GALV.
MOISTURE DRAIN CONE
COLLECTION CAN
SECURE FUNNEL TO TRIPOD BY BENDING THREE 1/2" x 8" STRIPS OF 28 GA SHEET METAL UNDER TRIPOD RING AND OVER TOP EDGE OF FUNNEL
1/8" x 1 1/2" FLAT GALV.
WELD
3/4" COUPLING
3/4" GALV. PIPE
3/8" IRON ROD
STAND
BALLAST GE 89 G 381 OR EQUIV
STARTER GE FS-2 OR EQUIV.
15W BLACK LIGHT FLUORESCENT GE. F15T8/BL OR EQUIV.
WIRING DIAGRAM
BALLAST COVER
24 GA GALV.
ENTRANCE HOLE FOR EXTENSION CORD, WITH RUBBER GROMMET
DRAIN HOLE
7/8" HOLE FOR STARTER
BALLAST COVER LAYOUT
BAFFLES
COLLECTION FUNNEL
STAND
BRACKET
COLLECTION CAN
TRAP ASSEMBLY
POSITION DIAGRAM
ELECTRIC INSECT TRAP
15-WATT OMNIDIRECTIONAL TYPE
2-62
U S DEPARTMENT OF AGRICULTURE, ARS, FARM ELECTRIFICATION BRANCH, AE, & TEXAS AGRICULTURAL EXPERIMENT STATION, COLLEGE STATION, TEXAS

Figure 3.--8-watt omnidirectional survey trap.

A small. portable, omnidirectional trap equipped with an 8-watt BL fluorescent lamp. This trap was designed to be readily transportable and easily installed. It consists of three main components: (1) the lamp and baffle assembly, (2) a funnel, and (3) a large collection can which also serves as a mounting base for the other two components. The baffle assembly is constructed so that it may be inverted and fitted into the funnel, and thus protect the lamp and make a compact package for transportation. The lamp auxiliary equipment is mounted in a small metal box separate from the trap and is electrically connected by cables with polarized connectors. Rainwater is drained through a small screen-covered funnel in the bottom of the collection can. (Turn page for construction plan.)





ELECTRIC INSECT TRAP 8-WATT PORTABLE TYPE 2-62
U.S. DEPARTMENT OF AGRICULTURE, ARS, FARM ELECTRIFICATION BRANCH, AE, & TEXAS AGRICULTURAL EXPERIMENT STATION, COLLEGE STATION, TEXAS

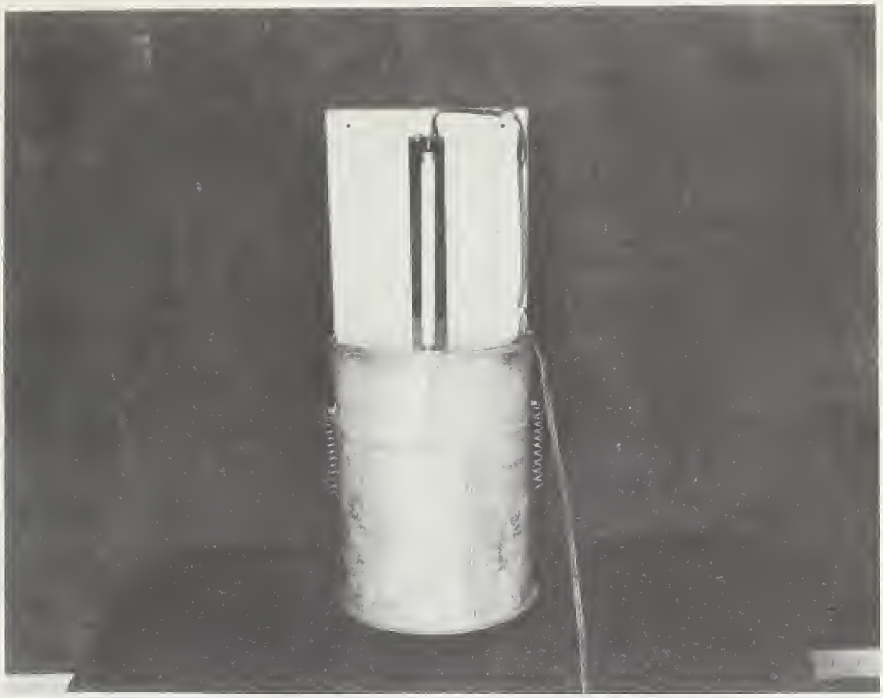
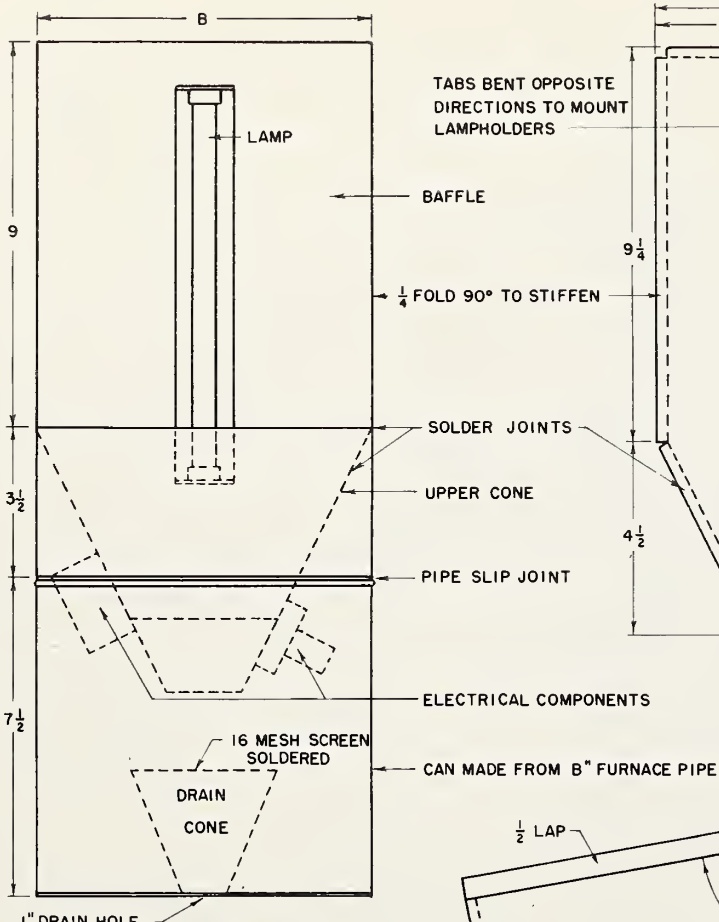
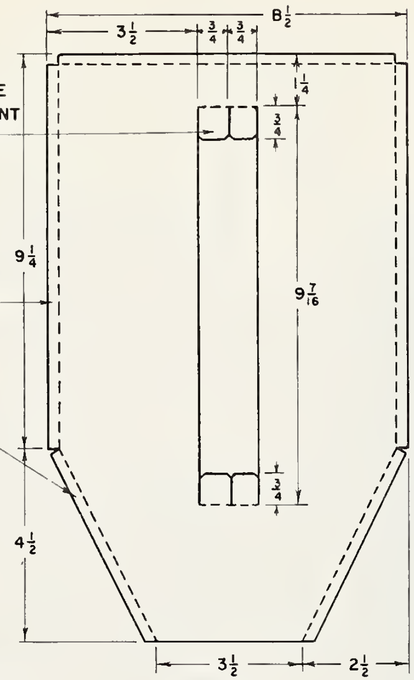


Figure 4.--6-watt omnidirectional survey trap.

This trap uses a 6-watt BL fluorescent lamp. It is a simple and inexpensive unit, constructed mainly from standard stovepipe. Its catches are about the same size as those from the 15-watt unidirectional trap but are more vulnerable to weather damage. (Turn page for construction plan.)

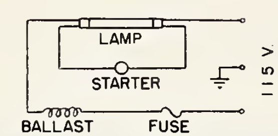


ASSEMBLY



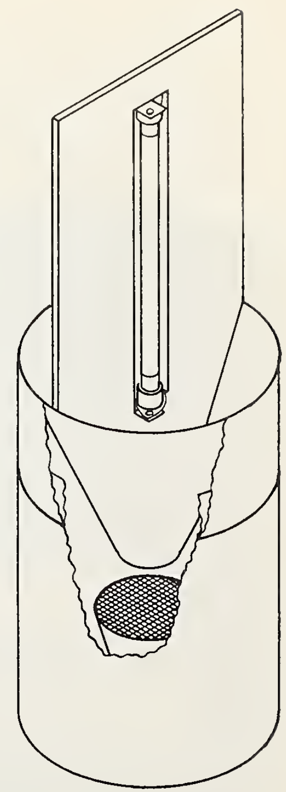
BAFFLE

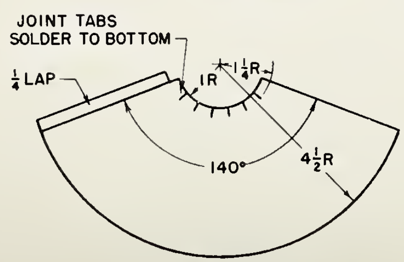
CIRCUIT



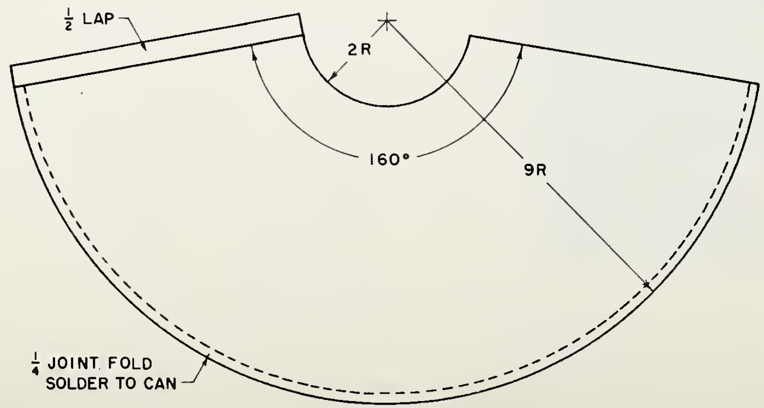
COMPONENTS

LAMPHOLDERS (2) - GE 95X276
LAMP - F6T5/BL
STARTERHOLDER - GE 95X299
STARTER - FS5
BALLAST - GE B9G435
FUSEHOLDER - BUSS HHJ
FUSE - BUSS AGC 1 AMP.
EQUIVALENTS OF ABOVE PARTS
MAY BE UTILIZED





DRAIN CONE



UPPER CONE

NOTES:

1. MATERIAL: 26 GAUGE GALVANIZED STEEL
2. CAN MADE FROM TWO SECTIONS OF 8-INCH FURNACE PIPE CONNECTED BY SLIP JOINT. SOLDER UPPER CONE TO TOP SECTION AND BOTTOM WITH DRAIN TO LOWER SECTION.
3. MOUNT ELECTRICAL COMPONENTS UNDER CONE OR IN EXTERNAL BOX (NOT SHOWN).

ELECTRIC INSECT TRAP 6-WATT OMNIDIRECTIONAL TYPE 2-62
U. S. DEPARTMENT OF AGRICULTURE, ARS FARM ELECTRIFICATION BRANCH, AE, & PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION, LAFAYETTE, IND.

Figure 5.--Pink bollworm survey trap with portable power supply.

This trap has been used extensively in Arizona and California for pink bollworm detection and survey work. A special feature is that it is equipped with three, 2-watt argon glow lamps. Like BL fluorescent lamps, the principal emission of these lamps is concentrated in the near ultraviolet region of the spectrum. Lamps of this type and wattage are nearly as effective as BL fluorescent lamps for attracting the pink bollworm moth, but are much less attractive to insects in general, particularly large moths and beetles. This helps to reduce damage to the rather delicate pink bollworm moths, which must be in near perfect condition for positive determinations. Since the power required for operating the lamp is low (6 watts), this trap lends itself well for use with portable power supplies. A portable power supply utilizing an automotive-type battery as the basic power source is shown here. The trap is operated from conventional 115-volt, 60-cycle a.c. when a source is readily available.

Figure 6.--Suction trap for tobacco warehouses.

Suction-type traps have been investigated by entomologists of the Agricultural Marketing Service and used by various tobacco companies as a means for determining infestations of, and timing control measures for, the cigarette beetle in tobacco storage warehouses. The trap shown here is equipped with a circular BL fluorescent lamp, whereas incandescent lamps (40- or 50-watt size) are used on most of the standard traps. BL lamps have been found to be two to three times more attractive than the incandescent type. When used, the incandescent lamp is suspended under the hood in front of the 1/20-horsepower motor which operates a fan. The fan forces the insects through a mesh cone into the retaining jar.

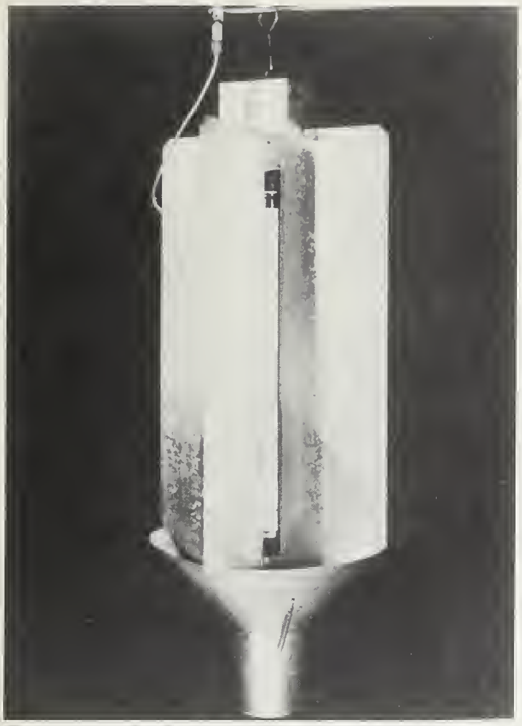


Figure 7.--European chafer beetle survey trap.

This trap is used by the Plant Pest Control Division in surveys for the European chafer. The chafer is a relative of the common "May beetle" and the larvae are a serious pest of turf and small grains in certain areas of the Northeast. Special features of the trap include (1) a screen-bottomed collection container to hold the beetles alive and permit escape of small insects, (2) a rather flat funnel angle with a small (3/4-inch) opening which permits large moths to crawl out of the trap, and (3) a special wiring circuit which permits operation of the lamp either from conventional a.c. power or from d.c. batteries by the use of a special inverter. The parts are especially designed for compact shipment and easy assembly in the field

Figure 8.--Mosquito trap.

This trap, known as the New Jersey mosquito trap, was developed a number of years ago as a result of a need for a convenient method of sampling mosquito population; it has become the accepted standard tool for this purpose. The trap uses a 25-watt incandescent lamp as an attractant and is equipped with a small fan which forces a draft of air by the lamp and down through a screen funnel to which the collection jar is attached. The conical roof which supports the lamp and other trap components extends over the funnel opening which keeps rainwater out of the collection jar. A 5/16-inch mesh screen ordinarily is used around the upper opening into the trap to keep large insects out of the mosquito collection.

Some operators use isopropyl alcohol as the killing agent. When employed, enough is used to cause the insects to be submersed as they are caught. After the specimens are dried, they are in good condition for identification.

Combinations of killing agents are sometimes used. Whether used singly or in combination, the amount required depends on local factors such as temperature, humidity, and air movement. It is usually necessary to renew the agent daily.

Live specimens of certain of the larger moths and beetles can be collected satisfactorily. Plastic screen bags are effective for restraining the insects. Depending on the mesh size of the screen, many of the smaller insects are permitted to escape. This reduces the size of the collection and eliminates some of the work required in sorting and searching for a particular species. Certain insects can chew through many cloth and plastic materials, so the fabric for such collection bags must be carefully chosen. If the insects must be held for extended periods, cages with screen wire covering may be required.

Separation of the catch by species and numbers is one of the major problems associated with the use of electric traps for insect surveys. The number of insects caught is frequently large, and taxonomic skill and considerable time are required for accurate determinations. Some operators identify specimens from proportionate samples of the total catch, with only a cursory examination of the remainder of the collection. Others separate the insects according to size by screening when interested in species that can be removed from the total collection in this manner. When identification work cannot be performed immediately, the collections may be preserved by drying or freezing.

Flying scales from moths create a serious dust nuisance in areas where insects are being identified, so good ventilation of the work area must be provided and consideration given to allergic reactions of employees. Use of dust masks may be necessary.

Where collections are mailed to remote points for identification, decay problems may be encountered. Catches should be mailed promptly in as dry a condition as possible. To prevent breakage, the specimens should be placed between layers of facial tissue or cellucotton and sent in a box or other container that is not easily crushed. Arrangements for prompt processing or storage at the receiving station are also essential.

PHOTOPOSITIVE INSECTS

The adults of thousands of species of insects are photopositive and may be collected at light traps. In some orders, nearly all species are photopositive; in others, nearly all species of certain families are, and in still others, only certain species of a family are.

Nearly all species of the following orders are photopositive: Dermaptera (earwigs), Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). In the order Lepidoptera nearly all nocturnal moths are photopositive, while in the orders Coleoptera, Homoptera, Hemiptera, and Diptera, many species of certain families are. Among the common families of Coleoptera that are photopositive are the ground beetles (Carabidae), the predaceous diving beetles (Dytiscidae), the water scavenger beetles (Hydrophilidae), the May beetles, dung beetles, scarab beetles and leaf-chafers (Scarabaeidae), the click beetles (Elateridae), carrion beetles (Silphidae), and the snout beetles (Curculionidae).

In the order Homoptera many leafhoppers (family Cicadellidae) and winged aphids (Aphidae), among others, are photopositive. In the Hemiptera most species of the families Corixidae (water boatmen), Belostomatidae (giant waterbugs), Miridae (plant bugs), and Reduviidae (assassin bugs), are photopositive and in the Diptera many species of mosquitoes (Culicidae), moth flies (Psychodidae), midges (Chironomidae), fungus gnats (Mycetophilidae), and vinegar flies (Drosophilidae) are.

Since so many factors influence the flight of insects to light traps, it should be clearly understood that just because a species of insect is attracted to light it does not follow that it can be controlled by the use of light traps.

A partial list of the common economic insect species that have been attracted to survey traps, equipped with BL lamps, follows:

COLEOPTERA

Asiatic garden beetle..................	*Maladera castanea* (Arrow)
Carrot beetle..........................	*Bothynus gibbosus* (De Geer)
Cigarette beetle	*Lasioderma serricorne* (Fabricius)
Click beetles..........................	Many species of family Elateridae
Elm leaf beetle........................	*Galerucella xanthomelaena* (Schr.)
European chafer........................	*Amphimallon majalis* (Razoumowsky)
"May beetles"..........................	genus *Phyllophaga*

Northern corn rootworm................	_Diabrotica_ _longicornis_ (Say)
Northern masked chafer.................	_Cyclocephala_ _borealis_ Arrow
Plum curculio..........................	_Conotrachelus_ _nenuphar_ (Herbst)
Seed-corn beetle.......................	_Agonoderus_ _lecontei_ Chaudoir
Spotted cucumber beetle................	_Diabrotica_ _undecimpunctata_ _howardi_ Barber
Striped blister beetle.................	_Epicauta_ _vittata_ (Fabricius)
Striped cucumber beetle................	_Acalymma_ _vittata_ (F.)
Three-striped blister beetle..........	_Epicauta_ _lemniscata_ (Fabricius)

DIPTERA

"Black scavenger flies"...............	Many species of family Sepsidae
Cabbage maggot.........................	_Hylemya_ _brassicae_ (Bouché)
Clear Lake gnat........................	_Chaoborus_ _astictopus_ Dyar & Shannon
"Eye gnats"............................	species of genus _Hippelates_
House fly..............................	_Musca_ _domestica_ Linnaeus
Mosquitoes.............................	Many species of family Culicidae
Moth flies.............................	Many species of family Psychodidae
Vinegar flies..........................	Many species of family Drosophilidae

HEMIPTERA

Alfalfa plant bug......................	_Adelphocoris_ _lineolatus_ (Goeze)
Cotton fleahopper......................	_Psallus_ _seriatus_ (Reuter)
Green stink bug........................	_Acrosternum_ _hilare_ (Say)
Rapid plant bug........................	_Adelphocoris_ _rapidus_ (Say)

HEMIPTERA--Continued

Tarnished plant bug....................	*Lygus lineolaris* (Palisot de Beauvois)

HOMOPTERA

Aphids or plant-lice..................	Many species of family Aphidae
Leafhoppers............................	Many species of family Cicadellidae

LEPIDOPTERA

Ailanthus webworm......................	*Atteva aurea* (Fitch)
Almond moth............................	*Ephestia cautella* (Walker)
Armyworm...............................	*Pseudaletia unipuncta* (Haworth)
Banded woollybear......................	*Isia isabella* (J. E. Smith)
Cabbage looper.........................	*Trichoplusia ni* (Hübner)
Catalpa sphinx.........................	*Ceratomia catalpae* (Boisduval)
Celery looper..........................	*Anagrapha falcifera* (Kirby)
Clover looper..........................	*Caenurgina crassiuscula* (Haworth)
Codling moth...........................	*Carpocapsa pomonella* (Linnaeus)
Corn earworm...........................	*Heliothis zea* (Boddie)
Cotton bollworm........................	*Heliothis zea* (Boddie)
Cotton leafworm........................	*Alabama argillacea* (Hübner)
Cutworms...............................	Many species of family Noctuidae
Eastern tent caterpillar...............	*Malacosoma americanum* (Fabricius)
European corn borer....................	*Ostrinia nubilalis* (Hübner)
Fall armyworm..........................	*Laphygma frugiperda* (J. E. Smith)
Forage looper..........................	*Caenurgina erechtea* (Cramer)
Garden webworm.........................	*Loxostege similalis* (Guénée)

Greenhouse leaf tier..................	*Udea rubigalis* (Guénée)
Indian-meal moth......................	*Plodia interpunctella* (Hübner)
Lesser cornstalk borer................	*Elasmopalpus lignosellus* (Zeller)
Pink bollworm.........................	*Pectinophora gossypiella* (Saunders)
Spruce budworm........................	*Choristoneura fumiferana* (Clemens)
Stalk borer...........................	*Papaipema nebris* (Guénée)
Tobacco budworm.......................	*Heliothis virescens* (Fabricius)
Tobacco hornworm......................	*Protoparce sexta* (Johannson)
Tobacco moth..........................	*Ephestia elutella* (Hübner)
Tomato fruitworm......................	*Heliothis zea* (Boddie)
Tomato hornworm.......................	*Protoparce quinquemaculata* (Haworth)
Yellow-striped armyworm...............	*Prodenia ornithogalli* Guénée

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